

## **RETRACTABLE HARDTOP WITH ARTICULATING CENTER PANEL**

### **REFERENCE TO RELATED APPLICATIONS**

This application claims priority from U.S. provisional patent application Serial No. 60/464,020, filed April 18, 2003, the entire contents of which is incorporated herein.

### **FIELD OF THE INVENTION**

5           The invention relates to retractable hardtops for automotive vehicles. More particularly, the invention relates to a hardtop having a center panel that is movable between front and rear panels when the hardtop is in the retracted position to provide additional luggage space.

### **BACKGROUND OF THE INVENTION**

10           Most vehicles have rigid roof structures that permanently extend over and cover the passenger compartment. Manufacturers also provide a variety of designs that offer the vehicle operator the opportunity to partially or completely uncover the passenger compartment. Sunroofs and moonroofs are some of the simplest designs and offer the opportunity to open a portion of the vehicle roof for increased airflow. More complicated  
15 designs allow the entire roof structure to be retracted and stored behind the passenger compartment.

Retractable roof systems generally fall into two categories. The most common type of retractable roof design is a convertible soft top or roof. These designs include an articulating structural framework with a flexible cloth or plastic outer skin. In an  
20 extended position, the front end of the articulating framework connects to a header above the vehicle windshield and the outer skin extends over the passenger compartment. When retracted, the articulating mechanism, along with the outer skin, folds into a compact shape. While convertible soft tops offer the choice between a covered or uncovered passenger compartment, they also suffer from several disadvantages in  
25 comparison to traditional rigid roof structures. Vehicles with soft tops are typically less

well sealed against the elements and are somewhat noisy. They are also less resistant to break-in attempts and have a less finished interior appearance.

The other retractable roof design is a retractable or folding hardtop roof system. Retractable hardtops consist of one or more rigid roof elements that are mechanically articulated such that they can be repositioned into a storage area behind the passenger compartment. Because the retractable hardtop consists of rigid sections, the system can provide a much closer approximation of a traditional rigid roof structure. In the extended position, a retractable hardtop securely covers and seals the passenger compartment, giving the appearance of a permanent roof. A retractable hardtop does a significantly better job of sealing the passenger compartment, reducing noise, and preventing break-ins. However, the retraction and storage of the hardtop presents significant mechanical challenges. Typically, when the retractable hardtop is in the retracted position, it resides in the portion of the vehicle traditionally provided for storage, such as the vehicle's trunk. While the storage space may be completely usable when the hardtop is in the extended position, most consumers prefer not to sacrifice the use of the storage position when the roof is retracted. There is generally a tradeoff between storage efficiency and mechanical complexity.

Most modern retractable hardtop designs consist of two or more articulated sections that are automatically folded or stacked in the storage area. In one design, referred to as a "clamshell" design, the roof structure is divided into a front section and a rear section. The front and rear sections are pivotally interconnected and the rear section is pivotally connected to a support structure behind the passenger compartment. Examples of clamshell type retractable hardtop designs are shown in U.S. Patent Nos. 6,217,104 to Neubrand, and 5,785,375 to Alexander et al.

In a clamshell design, the front and rear sections may both be the to have an inner and an outer surface, with the outer surfaces cooperating to form the outer surface of the roof structure when in the extended position. When retracted, the front section folds so as to bring the inner surface of the front section towards the inner surface of the rear section, and both sections are together positioned into the storage area. Often, the deck

lid of the vehicle articulates into an out-of-the-way position to allow the hardtop sections to move into a position in the trunk. The deck lid is then repositioned to cover the pair of roof sections. In most designs, the front and rear sections both have generally convex outer surfaces and concave inner surfaces. Therefore, when the inner surfaces are folded  
5 towards one another, the concave shapes cause there to be a significant distance between the mid-portions of the folded front and rear sections. Consequently, clamshell designs do not store as compactly as some other designs. Their advantage is that they are significantly less complex than most other designs. Reduced complexity not only reduces manufacturing costs, but also improves reliability of the system. Clamshell  
10 designs also have better structural integrity than some other designs.

An alternative design, which provides improved storage efficiency, may be referred to as a "stacking" design. Again, the roof is divided into two or more sections. However, when the hardtop is retracted, the roof sections are stacked such that the inner surface of one section is adjacent to the outer surface of another section. Because each  
15 section typically has a concave inner surface and a convex outer surface, placing the inner surface of one section next to the outer surface of another often results in more efficient space utilization. Examples of stacking retractable hardtop designs are shown in U.S. Patent Nos. 6,336,673 to Rothe et al., 6,318,793 to Rapin et al., 6,053,560 to Rothe, and 5, 979,970 to Rothe et al. As will be clear to those of skill in the art, stacking designs  
20 require significantly more complex articulation mechanisms than clamshell designs. This increased complexity leads to increased costs, reduced reliability, and reduced structural integrity.

### BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a side-elevational view of a portion of a vehicle with a first  
25 embodiment of a retractable hardtop according to the present invention;

Figure 2 is a side-elevational view of the retractable hardtop of Figure 1, with the top in a partially retracted position;

Figure 3 is a side-elevational view with the top in a more retracted position than is shown in Figure 2;

Figure 4 is a side-elevational view with the top in a more retracted position than is shown in Figure 3;

5 Figure 5 is a side-elevational view with the top in the fully retracted position;

Figure 6 is a side-elevational view of a second embodiment of a retractable hardtop according to the present invention, with some portions of the corresponding vehicle illustrated for context;

Figure 7 is a side-elevational view of the second embodiment of the top in a  
10 partially retracted position;

Figure 8 is a perspective view of the second embodiment of the top in a partially retracted position; and

Figure 9 is a side elevational view of the second embodiment of the top in a fully retracted position.

## 15 SUMMARY OF THE INVENTION

According to one aspect of the invention a retractable hardtop system is provided for use with a vehicle having a body defining a passenger compartment extending between a front windshield and a rear storage area. The hardtop system is movable between an extended position, wherein the hardtop system defines a roof over the passenger compartment and a retracted position, wherein at least a portion of the hardtop system is disposed in the storage area. The hardtop system includes a rear section pivotally coupled with the vehicle body. A front section is pivotally coupled with the rear section. The front section extends between the front windshield and the rear section when the hardtop is in the extended position. A center panel opening is defined between the rear and front sections. A balance link has a first end pivotally interconnect with the front section and a second end pivotally interconnected with the vehicle body. A center panel is interconnected with the balance link for movement therewith. The center panel and balance beam link are configured such that when the top is in the extended position,

the center panel fills the center panel opening and when the top is in the retracted position, the center panel moves out of the center panel opening.

According to another aspect of the invention, the balance link includes a mid-portion extending between the first and second ends. The mid-portion of the balance link is operatively connected to the center panel, whereby the center panel remains generally parallel with the balance link during movement of the hardtop between the extended and retracted positions.

#### DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a retractable hardtop that is a modified clamshell design for use with an automotive vehicle. The hardtop includes articulating main front and rear sections. The hardtop also includes a center panel disposed between the front and rear sections that articulates independently of the remainder of the hardtop, so as to provide for more compact storage.

Figures 1 through 5 illustrate a first embodiment of a retractable hardtop 10. The hardtop 10 includes a front section 12 and a rear section 14. The rear section 14 includes a front end 14a and a rear end 14b. The front end 14a of the rear section 14 is generally forward of the rear end 14b when the hardtop 10 is in the extended position. The front section 12 also includes a front end 12a and a rear end 12b. The rear end 14b of the rear section 14 is pivotally coupled to the vehicle body 5 and the rear end 12b of the front section 12 is pivotally coupled to the front end 14a of the rear section 14 by a pivot 13 to allow movement of the hardtop 10 between an extended position, as shown in Figure 1, and a retracted position, as shown in Figure 5. This movement is described in greater detail below.

The rear section 14 includes a backlight 16 extending between spaced apart side portions 15. A center panel opening 17 is defined between the backlight 16 and the rear end 12b of the front section 12 and extends between the side portions 15. In a typical clamshell design, there is no such center panel opening and the backlight 16 either extends farther forwardly, or a rigid portion extends between the side portions 15

forwardly of the backlight 16. In the present invention, a center panel 18 fills this position, the center panel opening 17, and articulates independently of the front 12 and rear 14 sections. More specifically, a balance link 20 has a forward end 22 and a rearward end 24. The forward end 22 of the balance link 20 is pivotally interconnected to the front section 12. The rearward end 24 is pivotally interconnected to, or otherwise in mechanical communication with, the vehicle body 5. A mid-portion 23 of the balance link 20 extends between the forward 22 and rearward 24 ends. The center panel 18 is connected to the mid-portion 23 of the balance link 20 for movement in and out of the center panel opening 17 during movement of the hardtop 10 between the extended and retracted positions, respectively. Moreover, the center panel 18 remains generally parallel with the balance link 20 throughout the movement of the hardtop 10 between the extended and retracted positions. The balance link 20 also helps to define the motion profile of the front section 12 relative to the rear section 14. As will be clear to those of skill in the art, a balance link 20 is preferably provided adjacent each side of the hardtop 10, and the center panel 18 is connected to both.

As shown in Figure 1, when the hardtop 10 is in the extended position, the front section 12, rear section 14 and center panel 18 cooperate to form a continuous rigid roof. The roof in the extended position covers the passenger compartment of the vehicle and the forward end 12a of the front section 12 abuts the top of the windshield. Figure 2 illustrates the hardtop 10 at the beginning of its retraction. As the rear section 14 "flips over" or rotates clockwise, as viewed in the figures, the motion of the balance links 20 causes the center panel 18 to move away from the rear section 14. Figure 3 illustrates the hardtop 10 in approximately the halfway retracted position, while Figure 4 illustrates the hardtop 10 in yet a more retracted position. As shown, the rear section 14 has articulated further rearwardly, and the center panel 18 is further displaced by the balance links 20 from the rear section 14. Inner surfaces 12c and 14c of the front 12 and rear 14 sections move toward one another as the hardtop 10 continues its motion to the retracted position. Also, as the retractable hardtop 10 retracts from the extended position of Figure 1 to the

retracted position of Figure 5, the front section 12 maintains its generally horizontal orientation.

Figure 5 illustrates the hardtop 10 in the fully retracted position, and illustrates how additional storage area is provided. As is typical with retractable hardtops, the hardtop 10 is preferably stowed in what is otherwise the luggage compartment of the vehicle. A luggage separator is shown as 28. Normally, the separator 28 must extend rearwardly approximately at the level shown by a dotted line 28a to provide enough room for a clamshell retractable hardtop. However, the present invention provides significant additional storage area, as shown by line 29. The lines indicated by 29 illustrate an area between the two side portions 15 of the rear section, when it is stowed. This area extends upwardly to the underside of the front section 12 and fills the width available between the two side portions 15. This additional area is available because the center panel 18 has moved out of the way and into an area inside the rear section 14. Specifically, the center panel 18 is stored approximately adjacent the backlight 16 between the inner surfaces 12c and 14c of the front 12 and rear 14 sections, which is otherwise wasted space.

Referring now to Figures 6-9, a second embodiment of a retracted hardtop according to the present invention will be discussed. The hardtop 30 is similar to the first embodiment, but instead has three main sections instead of two. More specifically, the front section 32 of the hardtop 30 is now divided into a front panel 34 and a median panel 36 which are articulated with respect to one another. As with the previous embodiment, the rear section 38 includes the backlight 40 that extends between a pair of side portions 32. A center panel opening 43 is defined fore and aft between the median panel 36, the backlight 40 and laterally between the side portions 42. An articulating center panel 44 is positioned in the center panel opening 43. As with the previous embodiment, the center panel 44 is attached to a balance link 46, though the interconnection between the balance link 46 and center panel 44 is not shown in each of the figures. The center panel 44 moves with the balance link 46 and is displaced in and out of the center panel opening 43 during movement of the hardtop 30 between the extended position, shown in Figure 6, and the retracted position, shown in Figure 9, respectively. As should be clear to those of

skill in the art, the center panel 44 may be connected to the balance link 46 in a variety of ways.

In Figures 7 and 8, the top 30 is shown in a partially retracted position. A multi-link mechanism, generally indicated at 48, extends between the front 34 and median 36 panels. The multi-link mechanism 48 allows articulation of the front panel 34 with respect to the median panel 36. This mechanism 48 is driven by the relative motion of the rear section 38 and the median panel 36. Alternatively, the front panel 34 may slide with respect to the medium panel 36, or may articulate in other ways than shown.

Figure 9 shows the top 30 in the retracted position. As shown, the front panel 34 and center panel 44 are both stored between the rear section 38 and median panel 36.

One important consideration in the design of retractable hardtop systems is water management. That is, it is preferred to avoid dumping water from a wet retractable roof into the passenger compartment when the top is retracted. For the center panel, one approach to water management, according to the present invention, is to provide a water trough on one or more sides of the center panel and a drain tube that runs down the balance link. Then, as the center panel separates from the remainder of the roof, water may flow off the center panel into the water trough, and down the drain tube. Other approaches may also be used.

As will be clear to those of skill in the art, the embodiments of the present invention described herein may be altered in various ways without departing from the scope or teaching of the present invention.

I claim: